

044. This circuit could be used as is or could be replicated and built into two or three layers giving more power and functionality. These variations and many others are well described in the literature, such as Hertz, Krogh, and Palmer, A Lecture Notes Volume in the Santa Fe Institute Studies in the Sciences of Complexity, Allen M. Wilde, Publ. (1991).

The typical application of this embodiment would require a neural network or computer program that at the primitive level can discern objects (finger touch points). This is the basic symbol, the presence of a finger, that is manipulated. From that point there may be predetermined gestures that the system looks for which indicate action. Motion may also need to be detected. A possible solution for this may be found in Mead, Analog VLSI and Neural Systems, Addison-Wesley (1989), Chapter 14, Optical Motion Sensor.

Because of the unique physical features of the present invention, there are several ergonomically interesting applications that were not previously possible. Presently a Mouse or Trackball is not physically convenient to use on portable computers. The present invention provides a very convenient and easy-to-use cursor position solution that replaces those devices.

In mouse-type applications, the sensor of the present invention may be placed in a convenient location, e.g., below the "space bar" key in a portable computer. When placed in this location, the thumb of the user may be used as the position pointer on the sensor to control the cursor position on the computer screen. The cursor may then be moved without the need for the user's fingers to leave the keyboard. Ergonomically, this is similar to the concept of the Macintosh Power Book with its trackball, however the present invention provides a significant advantage in size over the track ball. Extensions of this basic idea are possible in that two sensors could be placed below the "space bar" key for even more feature control.

The computer display with its cursor feedback is one small example of a very general area of application where a display could be a field of lights or LED's, a LCD display, or a CRT. Examples include touch controls on laboratory equipment where present equipment uses a knob/button/touch screen combination. Because of the articulating ability of this interface, one or more of those inputs could be combined into one of our inputs.

Consumer Electronic Equipment (stereos, graphic equalizers, mixers) applications often utilize significant front panel surface area for slide potentiometers because variable control is needed. The present invention can provide such control in one small touch pad location. As Electronic Home Systems become more common, denser and more powerful human interface is needed. The sensor technology of the present invention permits a very dense control panel. Hand Held TV/VCR/Stereo controls could be ergonomically formed and allow for more powerful features if this sensor technology is used.

The sensor of the present invention can be conformed to any surface and can be made to detect multiple touching points, making possible a more powerful joystick. The unique pressure detection ability of the sensor technology of the present invention is also key to this application. Computer games, "remote" controls (hobby electronics, planes), and machine tool controls are a few examples of applications which would benefit from the sensor technology of the present invention.

Musical keyboards (synthesizers, electric pianos) require velocity sensitive keys which can be provided by the pressure sensing ability of this sensor. There are also pitch bending controls, and other slide switches that could be

replaced with this technology. An even more unique application comprises a musical instrument that creates notes as a function of the position and pressure of the hands and fingers in a very articulate 3-d interface.

The sensor technology of the present invention can best detect any conducting material pressing against it. By adding a conductive foam material on top of the sensor the sensor of the present invention may also indirectly detect pressure from any object being handled, regardless of its electrical conductivity.

Because of the amount of information available from this sensor it will serve very well as an input device to virtual reality machines. It is easy to envision a construction that allows position-monitoring in three dimensions and some degree of response (pressure) to actions.

While embodiments and applications of this invention have been shown and described, it would be apparent to those skilled in the art that many more modifications than mentioned above are possible without departing from the inventive concepts herein. The invention, therefore, is not to be restricted except in the spirit of the appended claims.

What is claimed is:

1. An object proximity sensor, including:

a plurality of spaced-apart conductive sensor pads disposed in a matrix of rows and columns on a substrate;

a plurality of row conductive lines disposed on said substrate and generally aligned with said rows, each of said row conductive lines electrically contacting every second one of said sensor pads in one of said rows;

a plurality of column conductive lines disposed on said substrate, insulated from said row conductive lines and generally aligned with said columns, each of said column conductive lines electrically contacting the ones of said sensor pads in one of said columns which are not contacted by said row conductive lines;

means for placing a step voltage onto each of said row conductive lines one at a time, and for simultaneously sensing the charge injected onto each of said column conductive lines in response to said step voltage placed onto each of said row conductive lines and for producing a set of object-sensed electrical signals related thereto.

2. The object proximity sensor of claim 1 wherein said row conductive lines are disposed on said first face of said substrate and said column conductive lines are disposed on a second face of said substrate opposite said first face.

3. The object proximity sensor of claim 1, further including:

means for sensing a no-object-present capacitance of each of said row conductive lines and for producing a set of no-object-present electrical signals related thereto; and means for subtracting said set of no-object-present electrical signals from said set of object-sensed electrical signals.

4. The object proximity sensor of claim 3 wherein said means for producing a set of no-object-present electrical signals related to said no-object-present capacitance of each of said row conductive lines comprises means for computing weighted minima of said object-sensed electrical signals thereof.

5. An object proximity sensor, including:

a plurality of spaced-apart conductive sensor pads disposed in a plurality of rows on a substrate, the ones of said sensor pads in odd numbered ones of said rows disposed along a first set of column positions and the ones of said sensor pads in even numbered ones of said